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MOOTW FAST Toolbox: A Loosely Coupled System

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Integrated Analysis Tools

Presentation Interests

- **Toolbox Synopsis**
  - Needs
  - Objectives
  - Tools
- **User Interface**
- **Toolbox Support to JCS J-8**
  - Toolbox Application
  - Methodology
  - S&T Initiative
- **Toolbox Usage at NPS**
  - Research using FAST
  - Curriculum Support

Defining MOOTW M&S Needs

MOOTW FAST Toolbox: A Loosely Coupled System

- **M&S deficiencies in OOTW**
  - WARSIM & JWARS ORD
  - PACOM's MOOTW Requirements Analysis
- **Comments identified in WARMOND**
  - M&S analytic tools to support JTF for OOTW. Current models do not provide the capability … particularly non-force-on-force, peacekeeping OOTW. (EUCOM)
  - CINC battle staffs currently lack a federated simulation that provides the detailed resolution needed in today's asymmetrical warfare environment. (JFCOM)
  - A standardized, collaborative and distributed crisis action planning tool for analyzing COA, especially in areas of OOTW and SASO. (PACOM,TRAC)
  - A model that can be used for missions disaster relief, refugee, peacekeeping, counter-drug and stability operations. (SOUTHCOM)
  - OOTW Simulation for SOF missions. (SOCOM)
- **Outreach generated listing of desired "FAST Features"**
- **SPG 06-11 identified Stability Operations as a major M&S shortfall**

OOTW: A Top Warfighter M&S Need

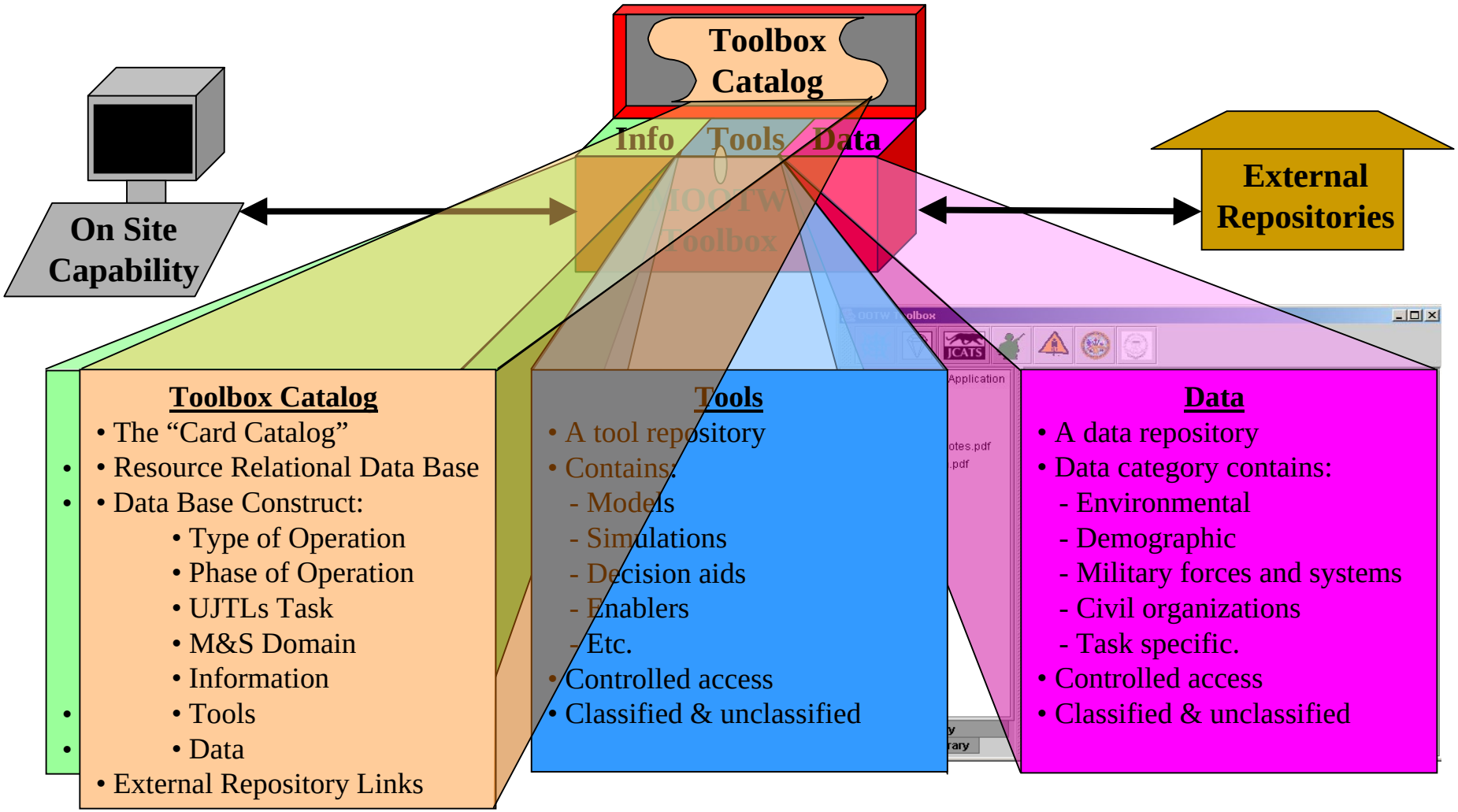
Toolbox Objectives

MOOTW FAST Toolbox: A Loosely Coupled System

- Build a prototype toolbox in a laptop for disparate M&S tools to operate in a complementary manner
- Selectively implement automated methodologies for tools to share data in support of operational planning & analysis
- Provide access to authoritative force & C^4I data
- Advance rapid update of scenario files
- Employ the toolbox in an MOOTW setting

Toolbox Controller

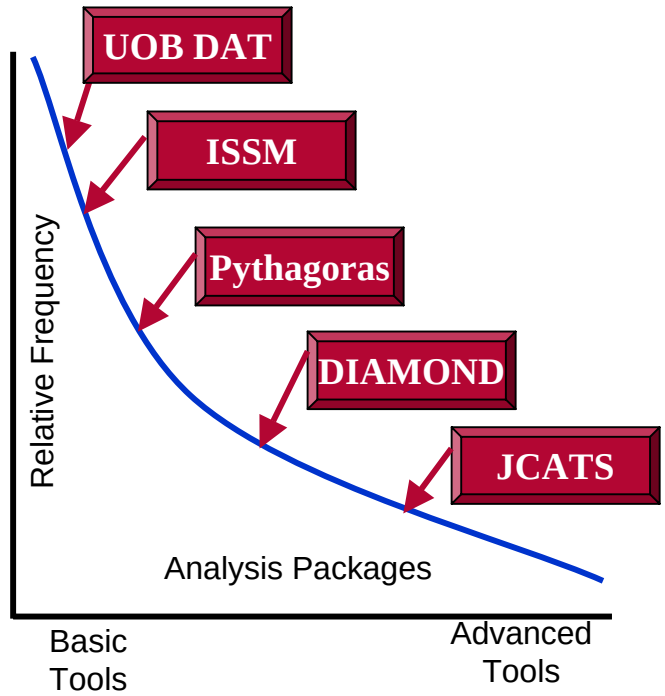
MOOTW FAST Toolbox: A Loosely Coupled System



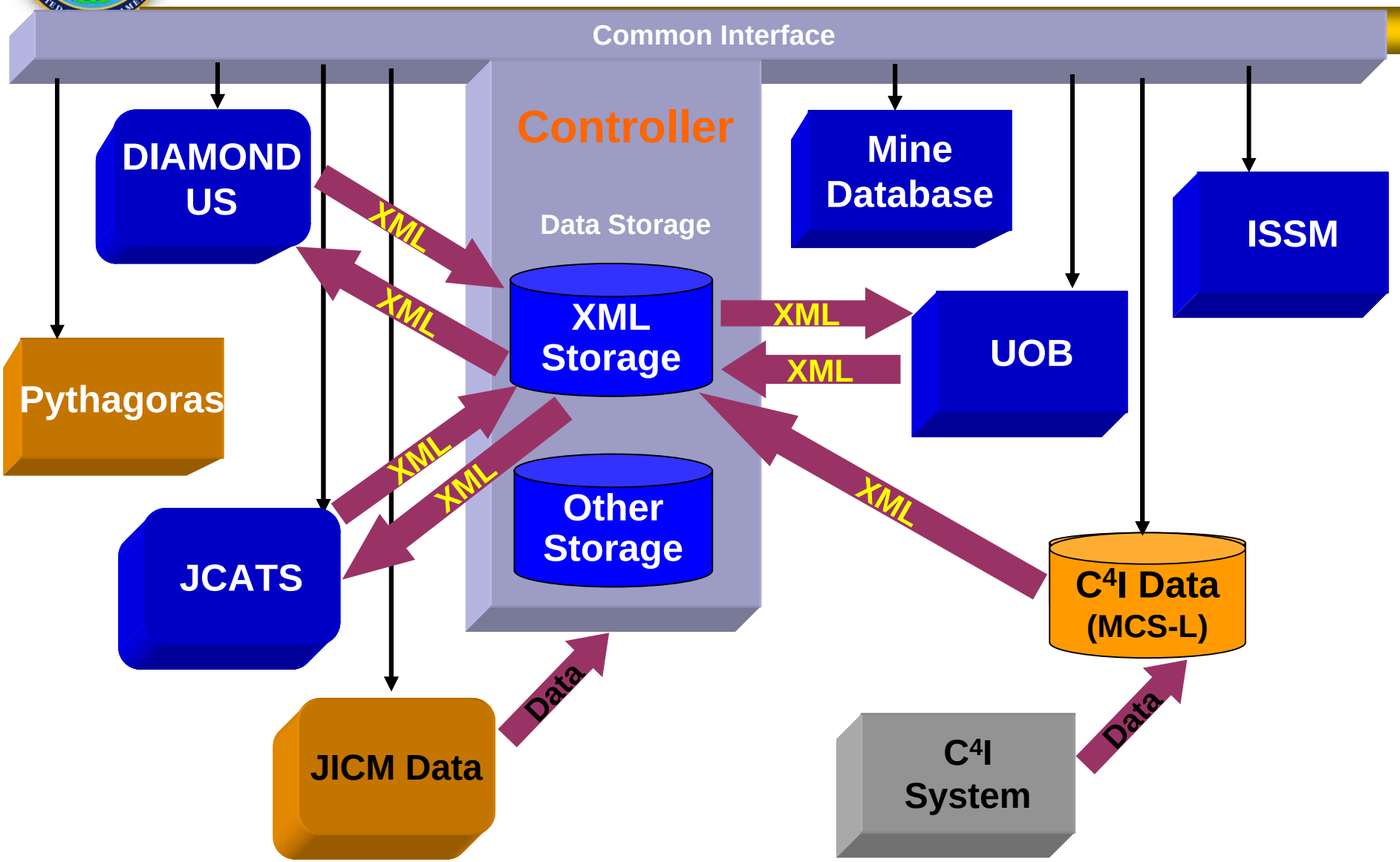
Tool Overview

MOOTW FAST Toolbox: A Loosely Coupled System

- **Canadian Forces Landmine Database**
  - Pictorial representation of over 350 mines cross referenced for tactical employment
- **Unit Order of Battle Data Access Tool**
  - Tailors forces & equipment to specific missions across the levels of war
- **Interim Semi-static Stability Model**
  - Civil stability & durable peace model applicable at the strategic & operational levels of war
- **Pythagoras**
  - Agent based distillation that can be applied across the levels of war
- **DIAMOND**
  - High-level simulation that advances planning/ analysis at the operational & tactical levels
- **Joint Conflict and Tactical Simulation**
  - Interactive simulation for conducting training & mission rehearsal at the tactical level



Architecture Roadmap

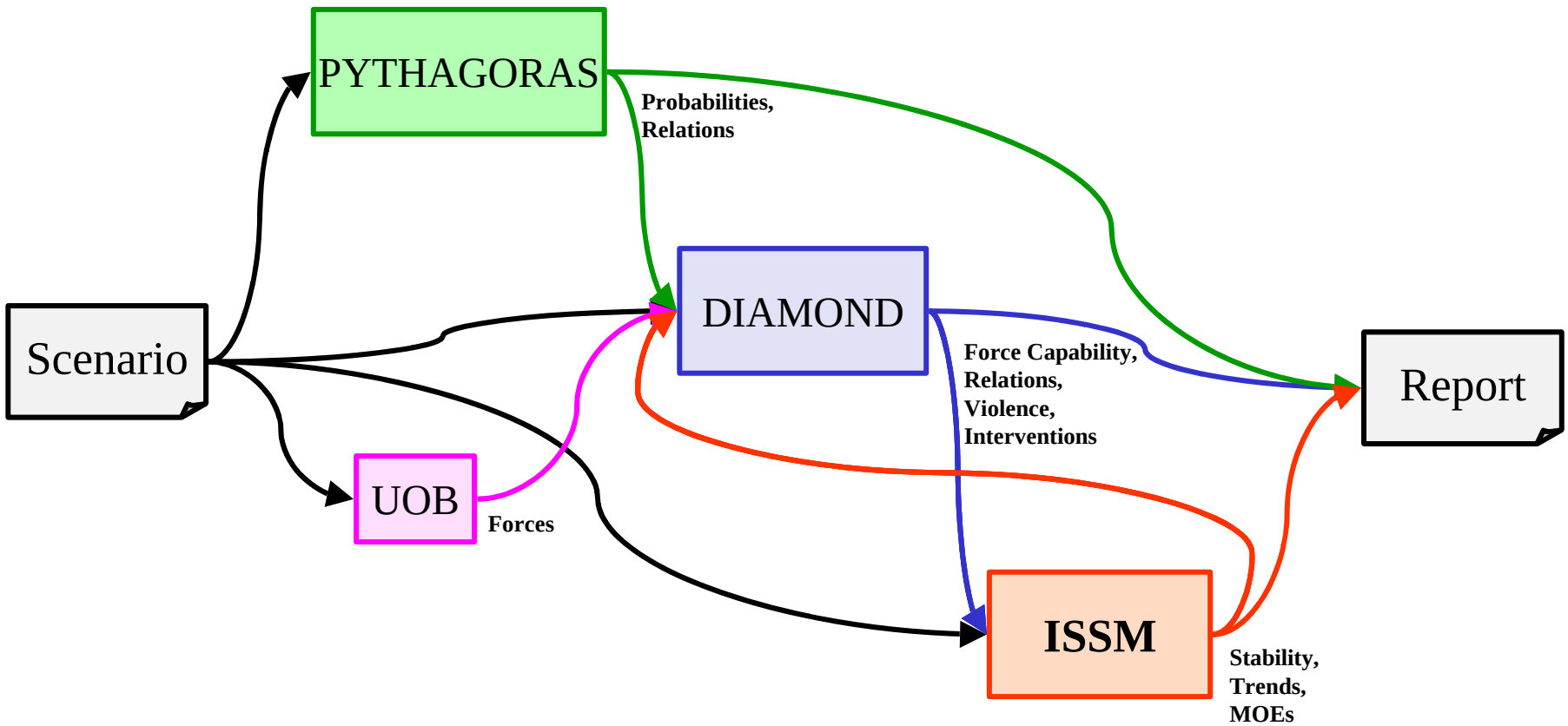


Interface with Users

- **Prototype Toolbox selectively used by CAA analyst in post-war Baghdad**
  - Evaluated UOB and ISSM concepts
- **Recommendations by CAA turned into 04 tasks**
  - UOB & ISSM
  - UOB enhancement used by DIAMOND-US
- **Who's using toolbox/tools**
  - JCS J-8: Funded 05 support of ESS Study
    - ✓Pythagoras, ISSM, UOB DAT, & DIAMOND-US
    - ✓Toolbox transition planned for during 06
  - USA G-2: DIAMOND-US & ISSM in support of study
    - ✓Toolbox requested in conjunction with study
  - CAA: DIAMOND-US in support of study
  - NPS: Toolbox being used in curriculum & ESS Study

Integrating Tools

MOOTW FAST Toolbox: A Loosely Coupled System

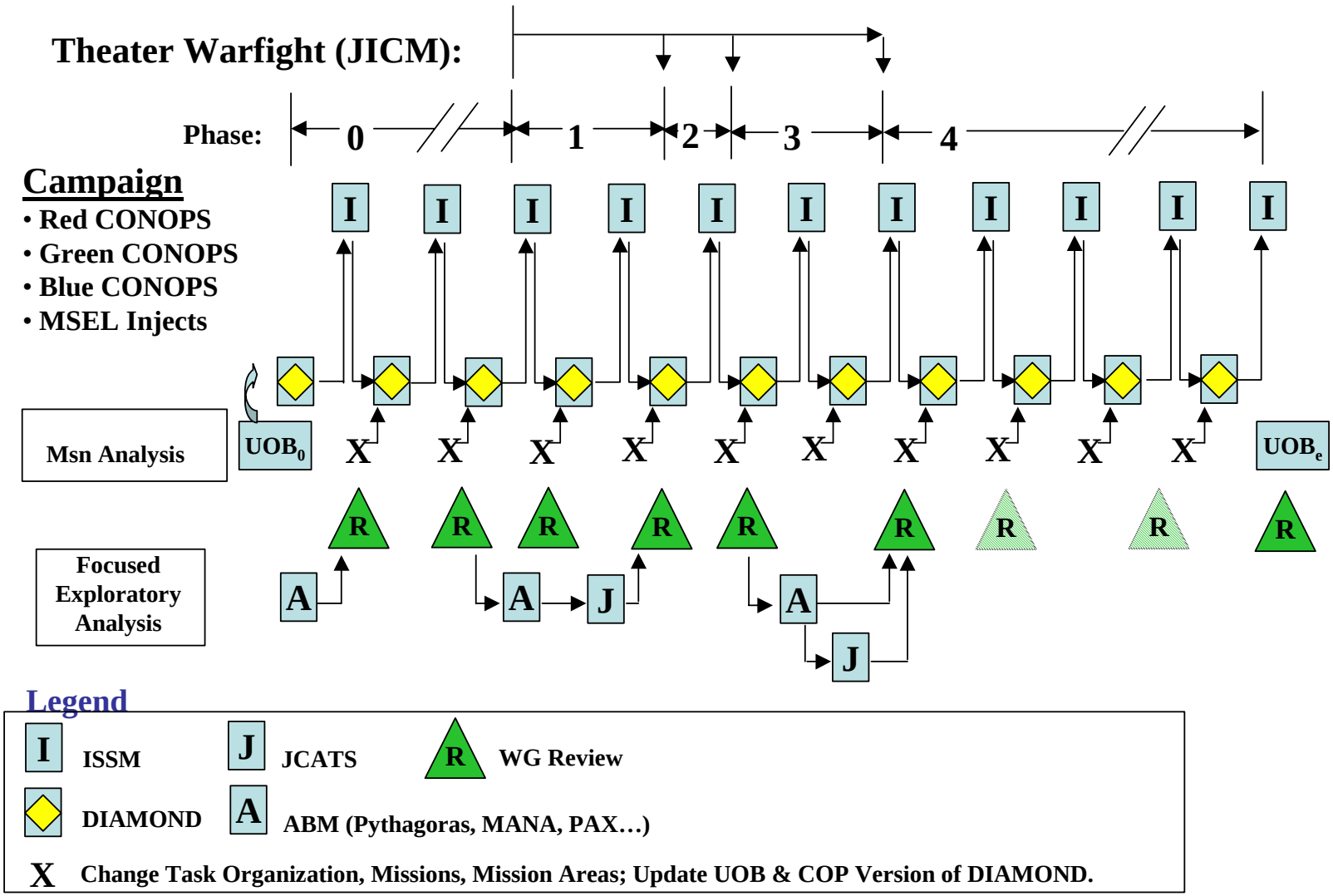


ESS Study MOE

- **Percent of Situational Understanding**
  - Percent of Expectations Met: Campaign Authority
- **Time Required to Achieve Security**
  - Local
    - ✓ Forces Used
    - ✓ Percent of Force Elements Employed
    - ✓ Capabilities Used
- **Country Stability Indicators**
  - Time Required to Provide Basic Needs: Food, Shelter, Water, etc.
    - ✓ Percentage of Supplies Delivered
- **Percent of Supporting Factions**
  - Time Required to Affect Faction Allegiance
- **Integration & Efficiency of NGOs**

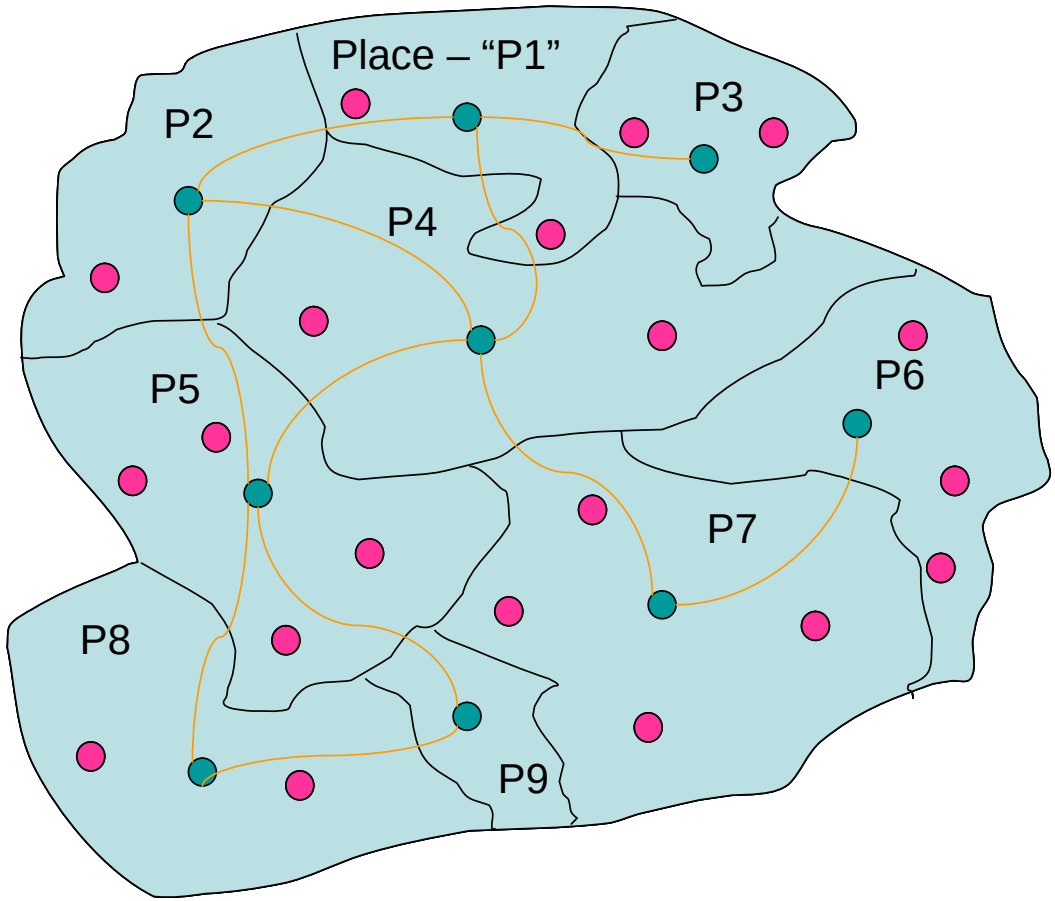
Methodology

MOOTW FAST Toolbox: A Loosely Coupled System



JICM

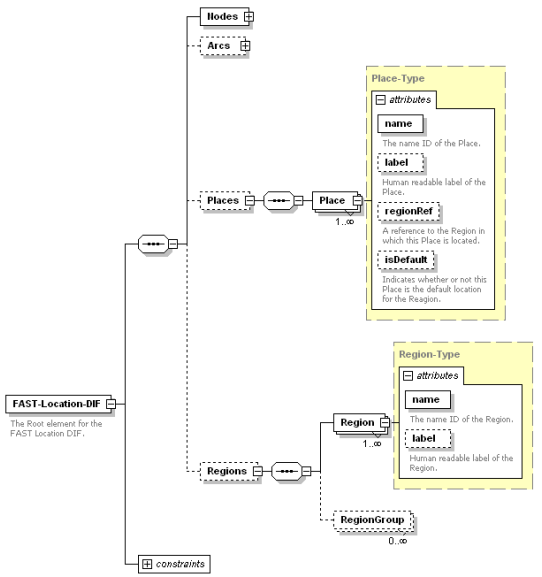
MOOTW FAST Toolbox: A Loosely Coupled System

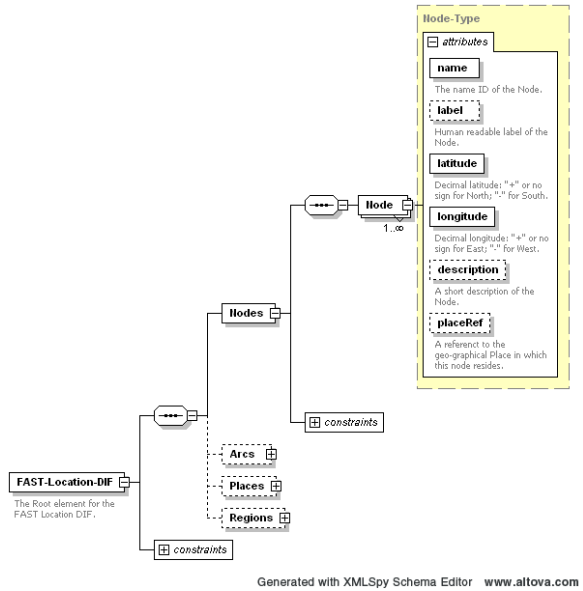


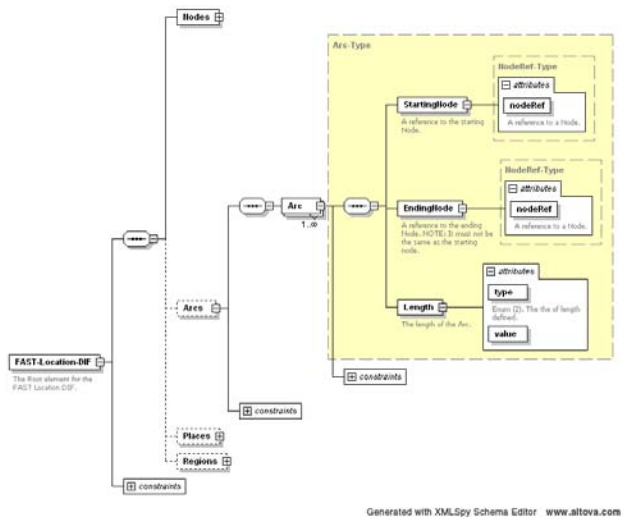
- JICM Place Centroid
- DIAMOND Node
- JICM Link

Data Interchange Format

MOOTW FAST Toolbox: A Loosely Coupled System







Using JICM data in the Toolbox

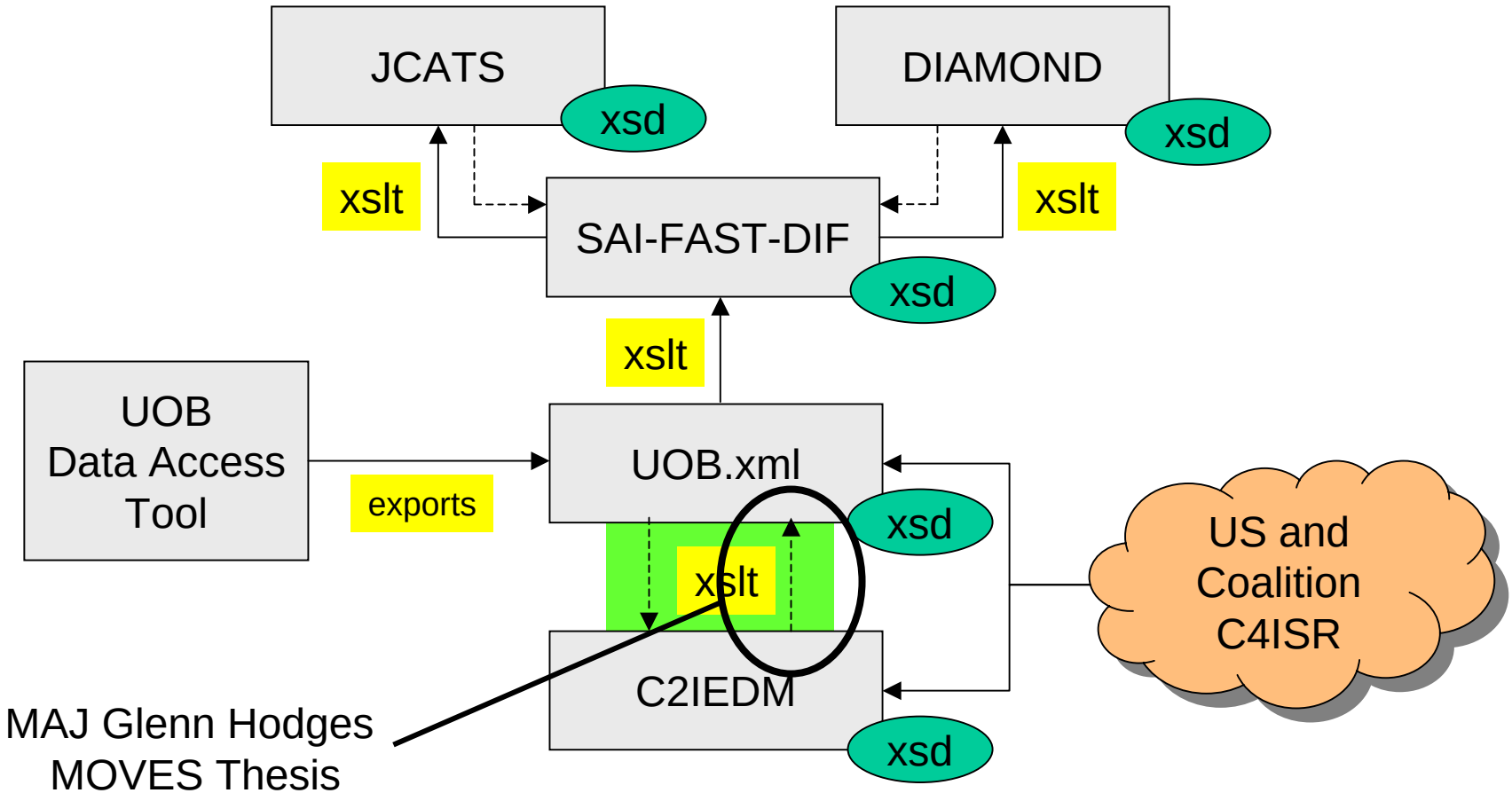
- Prototype DIF has been developed for XMT to import JICM places & links as Arcs & Nodes as initialization data for DIAMOND

Toolbox Use at NPS

- **Research**
  - Data Interchange
  - Agent-based Simulation
  - Candidate Tools
- **Education**
  - Curriculum Development
  - Student Thesis Research

Extending Unit Data Interchange

MOOTW FAST Toolbox: A Loosely Coupled System

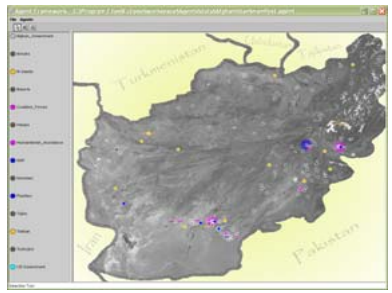


MAJ Glenn Hodges
MOVES Thesis
September 2004

Agent-Based Simulations

MOOTW FAST Toolbox: A Loosely Coupled System

- **Agent model built using NPS multi-agent simulation framework and initialized from DIAMOND Afghanistan scenario**
  - Units/Factions
  - Nodes/Arcs



- **Demonstrated that the use of open standards and exposed data structures enables arbitrary simulation models to readily read and operate on FAST data**
- **Conduct of studies using Pythagoras, PAX, Mana (refer to Profs Lucas and Sanchez)**

Design of Experiments

- Analysts often use large high-dimensional simulation models to provide insights to warfighters/decision-makers
- A design is a plan that specifies the input combinations of the variables
- Sample design:

	Factor 1	Factor 2	Factor 3
Run 1	High	Off	Yes
Run 2	High	On	No
Run 3	Low	On	Yes
Run 4	Low	Off	No
Run 5	Low	Off	Yes
Run 6	High	On	No

- Typically only a few variables are varied at two or three levels for a limited number of pre-determined alternatives instead of employing good experimental design techniques

Design of Experiments

- **LTC Tom Cioppa dissertation: "*Efficient nearly orthogonal and space-filling experimental designs for high-dimensional complex models*," NPS, 2002**
  - Orthogonality exists when each column of the design matrix has zero correlation with each of the other columns in the design matrix
    - ✓ Cause-and-effect relationships and quantitative assessment of critical interactions can be made
  - Space-filling means the design points are scattered throughout the multi-dimensional outcome space
    - ✓ Allows the design points to be spaced throughout the region
    - ✓ Opens up the ability to have multiple levels per factor, increasing the capability to explore a broader range of possibilities

Candidate Tools

- **Simkit/Viskit**
  - Discrete Event Simulation (DES) application program interface (API) in Java
  - Graphical User Interface for design and development of discrete event simulations (DES) using event graph notation and the Simkit DES application program interface
  - Repository of components and previously developed models
- **Incident Reporting System**
  - Network and Graph Markup Language (NaGML)
  - Visualization and analysis of incident data streams

Education: FAST in the Curriculum

- **New course conducted Spring (April-June) 2005: "*Modeling and Simulation (M&S) for Military Operations Other Than War (MOOTW)*"**
  - Multi-disciplinary (OA, MOVES, CS, IS)
  - Seminar format
  - Review MOOTW missions
  - Examine M&S requirements to support MOOTW
  - Explore existing applications in FAST (primarily DIAMOND and ISSM) and other existing/emerging simulations (e.g., agent-based models)

M&S for MOOTW: Course Description

- Course presented and discovered issues, challenges, and opportunities for application of M&S to MOOTW
- Considered application of M&S for MOOTW from the perspectives of analysis, training, acquisition, and mission planning/rehearsal
- Students had hands-on experience with current and emerging MOOTW M&S simulations and computational tools
  - ISSM, DIAMOND from the FAST Toolbox
  - MANA, Pythagoras from Project Albert

Student Project Outline

- ❑ Select problem area of interest
- ❑ Describe scenario
- ❑ Define MOEs/MOPs
- ❑ Design experiment
- ❑ Select model to support analysis
- ❑ Represent scenario in model
- ❑ Obtain data (provisional)
- ❑ Analyze and report results
- ❑ Report lessons learned and future directions

Student Project Topics

- Patrolling national waters
- Unmanned Aerial Vehicle (UAV) swarming
- Aggressiveness and population control
- Pier-side Force Protection
- Force allocation in protection of relief operations
- Protection of polling places in elections
- Protection of shipping
- Embassy reinforcement
- Oil infrastructure protection
- Border patrol
- Non-lethal weapons and crowd control

FAST: Student Thesis Research

- **MAJ Glenn Hodges, USA: "*Designing a Common Interchange Format for Unit Data Using the Command and Control Information Exchange Data Model (C2IEDM) and XSLT*", September 2004**

  http://www.movesinstitute.org/Theses/HodgesThesis.pdf

- **LCDR Shane Brown, USN: "*Analyses of Infrastructure Protection Using Network Optimization and Simulation Tools*", September 2005**

Toolbox End State

MOOTW FAST Toolbox: A Loosely Coupled System

- Addresses warfighter needs supporting MOOTW
- Enables one-stop shopping through an information-centric architecture
- Allows disparate applications to run on same laptop
- Provides access to authoritative force data via UOB DAT
- Advances complementary use of tools across levels of war to promote planning, analysis, and training supporting stability type missions within MOOTW
- Uses XML via automated processes to share data in a standardized environment that creates time savings
- Ingests C^4I data into the toolbox for simulation initialization/ update through XMT
- Reuses scenario data through XMT

QUESTIONS

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Back-ups

C2IEDM

- **Command and Control Information Exchange Data Model: Multilateral Interoperability Programme**
  http://www.mip-site.org
- **October 2004: XML tagset corresponding to the logical schema passed validation in the DoD Metadata Registry; posted in the COAL (Coalition) namespace**
  - All XML resources for both the physical and the logical representations are now available for review and download at the Registry Website: http://diides.ncr.disa.mil/xmlreg/user/index.cfm
  - Status of these tags is currently “Developmental”; status expected to change to “Operational” soon
- **November 2004: US Army drafting policy statements to require use of C2IEDM in the C4I and simulation domains**

Example 6-factor design (OLH)

Low level	5	10	5	5	-50	-50
High level	25	50	25	50	50	50
Factor name	Vehicle speed	Sensor range	Weapon range	Comms range	Toward live enemies	Toward live friends
	11	50	21	22	-25	44
	6	20	23	30	-50	-19
	8	28	6	16	13	31
	9	35	11	50	6	-38
	20	48	14	11	-19	-50
	25	23	13	42	-44	25
	18	18	25	19	38	-6
	16	45	20	47	31	13
	15	30	15	28	0	0
	19	10	9	33	25	-44
	24	40	8	25	50	19
	23	33	24	39	-13	-31
	21	25	19	5	-6	38
	10	13	16	44	19	50
	5	38	18	13	44	-25
	13	43	5	36	-38	6
	14	15	10	8	-31	-13

M&S for MOOTW: Primary Texts

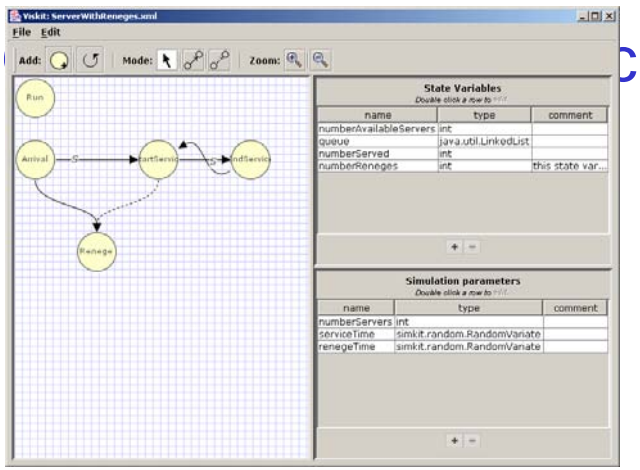
- Bradd C. Hayes and Jeffrey I. Sands, Doing Windows: Non-Traditional Military Responses to Complex Emergencies, CCRP, 1998 (http://www.dodccrp.org)
- D. S. Hartley III, "Operations Other Than War: Requirements for Analysis Tools Research Report," Center for Modeling, Simulation, and Gaming, K/DSRD-2098, December 1996
- Joint Publication 3-07, Joint Doctrine for Military Operations Other Than War, 16 June 1995
- Stability Operations Joint Operating Concept, US Joint Forces Command, September 2005

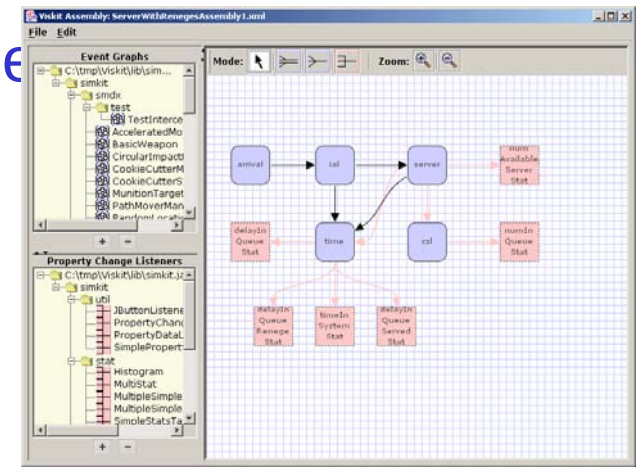
Simkit

- Application Program Interface (API) for building Discrete Event Simulation (DES) models
- Event list simulation engine
- Flexibility for random variate generation
- Simulation components based on Event Graphs
- Loose coupling of simulation components
- Extensive use of listener pattern for model building and data collection
- Platform-independent (Java)

Viskit

- Create and edit Simkit components visually
- Reduces need for programming expertise
- Eliminates many common errors
- Graphical assembly of components
- Saves components and assemblies in XML
- compone



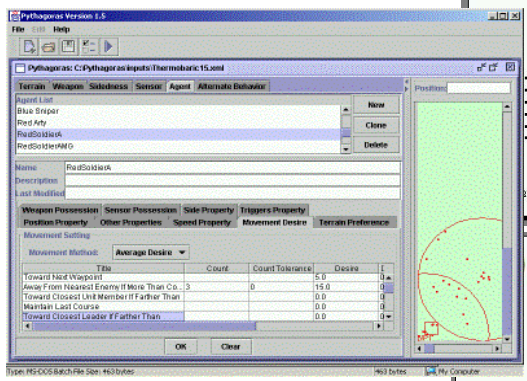


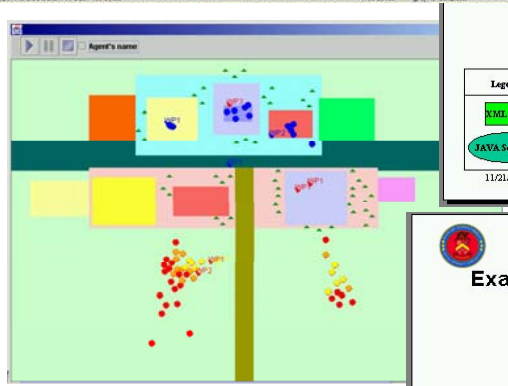
Pythagoras

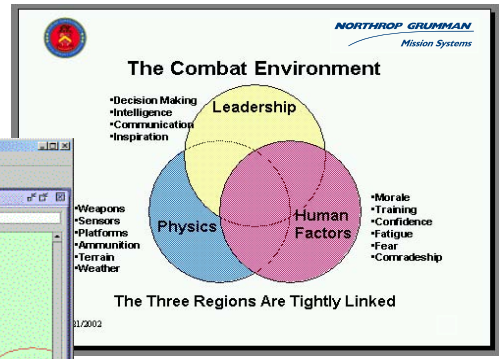
MOOTW FAST Toolbox: A Loosely Coupled System

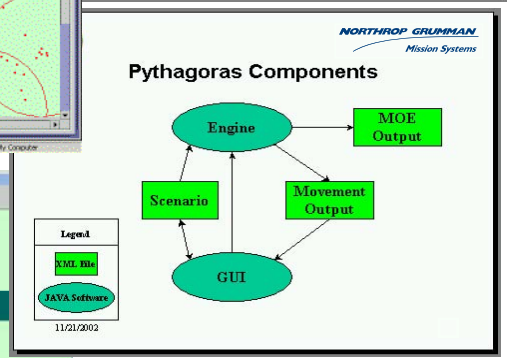
Agent-Based Technology

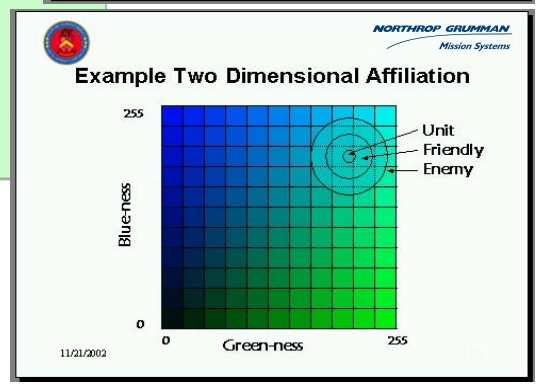
- Behaviors Rather Than Scripts
- Multiple Affiliations/Sides
- Traditional Capabilities
  - ✓ Weapons (Including Non-Lethal)
  - ✓ Sensors
- Peacetime Operations and War Time Engagements & Missions
- Computer Literacy Not Required
- Widely Applicable for Analysis
  - ✓ MOUT
  - ✓ Humanitarian Relief
  - ✓ ASW
  - ✓ Air Operations
  - ✓ Mine Clearing
  - ✓ Many Others









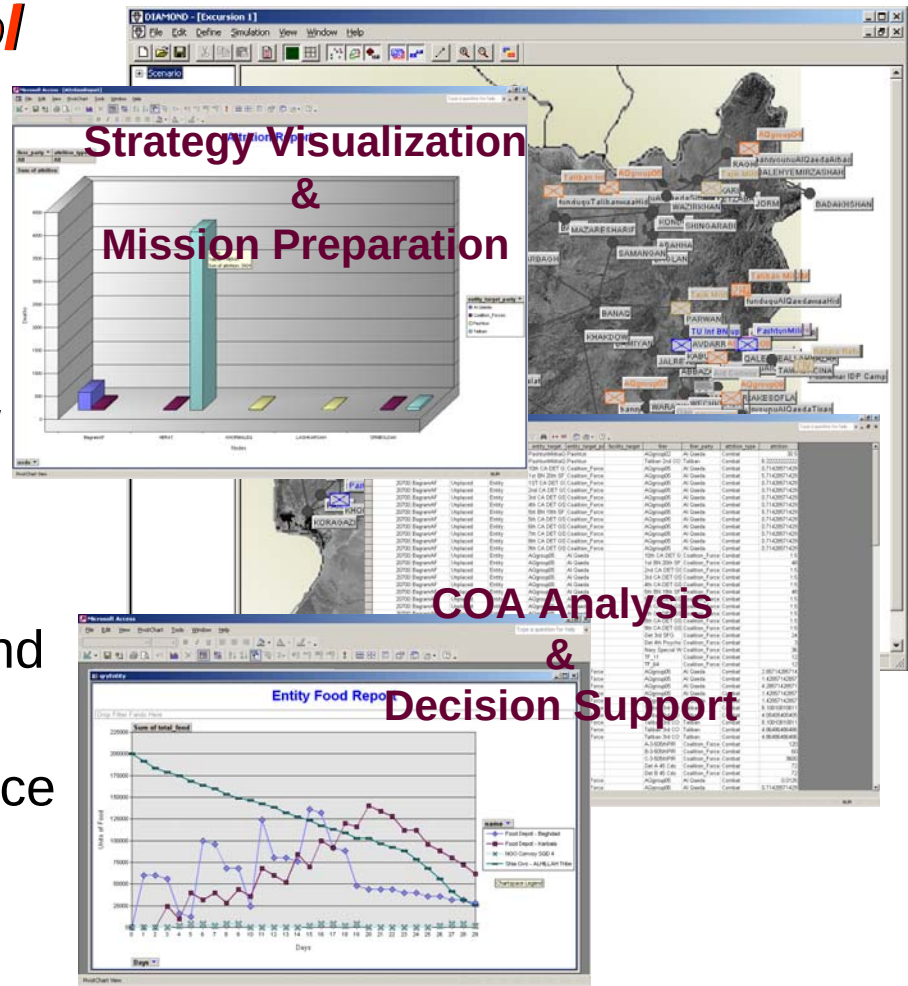


DIAMOND

MOOTW FAST Toolbox: A Loosely Coupled System

"Best Breed" OOTW Tool

- Low resolution campaign model
- Stochastic simulation
- Interactive and multi-sided/ROE
- C2 Mission-based Architecture
- Improves understanding of MOOTW
  - Represents stability functions
- Aims to:
  - Assess utility of military elements and equipment
  - Assess effectiveness of different force structures
  - Assess possible outcomes of operational strategies



ISSM

MOOTW FAST Toolbox: A Loosely Coupled System

Time Chart: Internal Inputs

Iraq, Scenario A: Core Values